

What is claimed is:

1 1. A semiconductor laser, comprising:
2 an n-type cladding layer that has n-type
3 conductivity;
4 an active layer formed on top of the n-type cladding
5 layer;
6 a p-type cladding base layer that is formed on top
7 of the active layer and has p-type conductivity;
8 a current-blocking layer that is formed on specified
9 parts of an upper surface of the p-type cladding base layer
10 and substantially has n-type conductivity; and
11 a p-type buried cladding layer that has p-type
12 conductivity and is formed so as to cover the
13 current-blocking layer and contact remaining parts of the
14 upper surface of the p-type cladding base layer,
15 wherein the current-blocking layer has at least two
16 regions having different concentrations (hereafter "N1"
17 and "N2" where $N1 < N2$) of n-type carriers, a region adjacent
18 to an interface between the p-type cladding base layer and
19 the p-type buried cladding layer having the N1
20 concentration of n-type carriers and a part or all of a
21 remaining region of the current-blocking layer region
22 having the N2 concentration.

1 2. A semiconductor laser according to Claim 1,
2 wherein the current-blocking layer includes a
3 first layer that contacts the p-type cladding base layer
4 and a second layer that is provided on top of the first
5 layer, a concentration of n-type carriers in the first
6 layer being N_1 and a concentration of n-type carriers in
7 the second layer being N_2 .

1 3. A semiconductor laser according to Claim 2,
2 wherein the first layer has a different
3 composition to the second layer.

1 4. A semiconductor laser according to Claim 2,
2 wherein one of the first layer and the second
3 layer is composed of a plurality of sublayers that have
4 at least two different compositions.

1 5. A semiconductor laser according to Claim 2,
2 wherein the second layer is co-doped with a p_2
3 concentration of p-type carriers and an n_2 (where $n_2 > p_2$)
4 concentration of n-type carriers, and n_2 and p_2 are set
5 so that $n_2 - p_2 = N_2$.

1 6. A semiconductor laser according to Claim 5,
2 wherein $0 \text{ cm}^{-3} \leq N_1 \leq 10^{17} \text{ cm}^{-3}$ and $N_2 > 10^{17} \text{ cm}^{-3}$.

1 7. A semiconductor laser according to Claim 4,
2 wherein $0\text{cm}^{-3} \leq N1 \leq 10^{17}\text{cm}^{-3}$ and $N2 > 10^{17}\text{cm}^{-3}$.

1 8. A semiconductor laser according to Claim 3,
2 wherein $0\text{cm}^{-3} \leq N1 \leq 10^{17}\text{cm}^{-3}$ and $N2 > 10^{17}\text{cm}^{-3}$.

1 9. A semiconductor laser according to Claim 2,
2 wherein $0\text{cm}^{-3} \leq N1 \leq 10^{17}\text{cm}^{-3}$ and $N2 > 10^{17}\text{cm}^{-3}$.

1 10. A semiconductor laser according to Claim 1,
2 wherein $0\text{cm}^{-3} \leq N1 \leq 10^{17}\text{cm}^{-3}$ and $N2 > 10^{17}\text{cm}^{-3}$.

1 11. A semiconductor laser, comprising:
2 an n-type cladding layer that has n-type
3 conductivity;
4 an active layer formed on top of the n-type cladding
5 layer;
6 a p-type cladding base layer that is formed on top
7 of the active layer and has p-type conductivity;
8 a current-blocking layer that is formed on specified
9 parts of an upper surface of the p-type cladding base layer
10 and substantially has n-type conductivity; and
11 a p-type buried cladding layer that has p-type
12 conductivity and is formed so as to cover the

13 current-blocking layer and contact remaining parts of the
14 upper surface of the p-type cladding base layer,
15 the current-blocking layer having a region with
16 p-type conductivity adjacent to the interface between the
17 p-type cladding base layer and the p-type buried cladding
18 layer and another region with n-type conductivity.

1 12. A semiconductor laser, comprising:
2 an n-type cladding layer that has n-type
3 conductivity;
4 an active layer formed on top of the n-type cladding
5 layer;
6 a p-type cladding base layer that is formed on top
7 of the active layer and has p-type conductivity;
8 an interjacent layer that has p-type conductivity and
9 is formed on specified parts of an upper surface of the
10 p-type cladding base layer and contacts the p-type cladding
11 base layer;
12 a current-blocking layer that is formed on the
13 interjacent layer and has n-type conductivity; and
14 a p-type buried cladding layer that has p-type
15 conductivity and is formed so as to cover the
16 current-blocking layer and contact remaining parts of the
17 upper surface of the p-type cladding base layer,

18 the interjacent layer being positioned between the
19 current-blocking layer and the p-type cladding base layer
20 so that a lower surface of the current-blocking layer is
21 separated from an upper surface of the p-type cladding base
22 layer.

1 13. A semiconductor laser according to Claim 12,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 14. A semiconductor laser according to Claim 11,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 15. A semiconductor laser according to Claim 10,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 16. A semiconductor laser according to Claim 9,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of laser light than the current-blocking
4 layer.

1 17. A semiconductor laser according to Claim 8,

2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 18. A semiconductor laser according to Claim 7,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 19. A semiconductor laser according to Claim 6,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 20. A semiconductor laser according to Claim 5,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 21. A semiconductor laser according to Claim 4,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 22. A semiconductor laser according to Claim 3,
2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 23. A semiconductor laser according to Claim 2,

2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 24. A semiconductor laser according to Claim 1,

2 wherein the p-type buried cladding layer has a higher
3 refractive index of light than the current-blocking layer.

1 25. A semiconductor laser manufacturing method,
2 comprising:

3 a first process for successively forming an n-type
4 cladding layer having n-type conductivity, an active layer,
5 and a p-type cladding base layer having p-type conductivity
6 on top of one another, before forming a current-blocking
7 layer, which substantially has n-type conductivity, on
8 specified parts of an upper surface of the p-type cladding
9 base layer;

10 a second process for performing thermal cleaning in
11 a presence of a specified gas after the first process has
12 finished;

13 a third process for forming, after the second process
14 has finished, a p-type buried cladding layer, which has
15 p-type conductivity, so as to cover the current-blocking
16 layer and contact remaining parts of the upper surface of
17 the p-type cladding base layer,

18 the first process including:

19 a first subprocess for forming a region of the
20 current-blocking layer that is adjacent to the interface
21 between the p-type cladding base layer and the p-type
22 buried cladding layer with a concentration (hereafter,
23 "N1") of n-type carriers; and

24 a second subprocess for forming another region
25 in at least part of the current-blocking layer with a
26 concentration (hereafter, "N2") of n-type carriers, where
27 $N1 < N2$.

1 26. A semiconductor laser manufacturing method according
2 to Claim 25,

3 wherein the first process produces the
4 current-blocking layer by forming a first layer that
5 contacts the p-type cladding base layer and a second layer
6 on top of the first layer, a concentration of n-type
7 carriers being N1 in the first layer and N2 in the second
8 layer.

1 27. A semiconductor laser manufacturing method according
2 to Claim 26,

3 wherein the first process forms the first layer from
4 a different composition of materials to the second layer.

1 28. A semiconductor laser manufacturing method according
2 to Claim 26,

3 wherein the first process produces one of the first
4 layer and the second layer by forming sublayers from at
5 least two different compositions of materials.

1 29. A semiconductor laser manufacturing method according
2 to Claim 26,

3 wherein the first process co-dopes the second layer
4 with a p2 concentration of p-type carriers and an n2 (where
5 $n_2 > p_2$) concentration of n-type carriers, and $N_2 = (n_2 - p_2)$.

1 30. A semiconductor laser manufacturing method according
2 to Claim 29,

3 wherein $0 \text{ cm}^{-3} \leq N_1 \leq 10^{17} \text{ cm}^{-3}$ and $N_2 > 10^{17} \text{ cm}^{-3}$.

1 31. A semiconductor laser manufacturing method according
2 to Claim 28,

3 wherein $0 \text{ cm}^{-3} \leq N_1 \leq 10^{17} \text{ cm}^{-3}$ and $N_2 > 10^{17} \text{ cm}^{-3}$.

1 32. A semiconductor laser manufacturing method according
2 to Claim 27,

3 wherein $0 \text{ cm}^{-3} \leq N_1 \leq 10^{17} \text{ cm}^{-3}$ and $N_2 > 10^{17} \text{ cm}^{-3}$.

1 33. A semiconductor laser manufacturing method according
2 to Claim 26,

3 wherein $0\text{cm}^{-3} \leq N1 \leq 10^{17}\text{cm}^{-3}$ and $N2 > 10^{17}\text{cm}^{-3}$.

1 34. A semiconductor laser manufacturing method according
2 to Claim 25,

3 wherein $0\text{cm}^{-3} \leq N1 \leq 10^{17}\text{cm}^{-3}$ and $N2 > 10^{17}\text{cm}^{-3}$.

1 35. A semiconductor laser manufacturing method,
2 comprising:

3 a first process for successively forming an n-type
4 cladding layer having n-type conductivity, an active layer,
5 and a p-type cladding base layer having p-type conductivity
6 on top of one another, before forming a current-blocking
7 layer, which substantially has n-type conductivity, on
8 specified parts of an upper surface of the p-type cladding
9 base layer;

10 a second process for performing thermal cleaning in
11 a presence of a specified gas after the first process has
12 finished;

13 a third process for forming, after the second process
14 has finished, a p-type buried cladding layer, which has
15 p-type conductivity, so as to cover the current-blocking
16 layer and contact remaining parts of the upper surface of

17 the p-type cladding base layer,
18 the first process forming the current-blocking layer
19 so as to include a region with n-type conductivity and a
20 region with p-type conductivity, the first process
21 including:

22 a first subprocess for forming a region with
23 p-type conductivity adjacent to an interface between the
24 p-type cladding base layer and the p-type buried cladding
25 layer; and

26 a second subprocess for forming a region with
27 n-type conductivity in at least part of a remainder of the
28 current-blocking layer.

1 36. A semiconductor laser manufacturing method,
2 comprising:

3 a first process for successively forming an n-type
4 cladding layer having n-type conductivity, an active layer,
5 a p-type cladding base layer having p-type conductivity,
6 and an interjacent layer that has p-type conductivity and
7 contacts the first p-type cladding base layer on top of
8 one another, before forming a current-blocking layer,
9 which substantially has n-type conductivity, on an upper
10 surface of the interjacent layer;

11 a second process for performing thermal cleaning in

12 a presence of a specified gas after the first process has
13 finished;

14 a third process for forming, after the second process
15 has finished, a p-type buried cladding layer, which has
16 p-type conductivity, so as to cover the current-blocking
17 layer and contact remaining parts of the upper surface of
18 the p-type cladding base layer,

19 the interjacent layer being formed between the
20 current blocking layer and the p-type cladding base layer
21 so that a lower surface of the current-blocking layer is
22 separated from an upper surface of the p-type cladding base
23 layer

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